J. mar. biol. Ass. India, **45** (2) : 195 - 207, July - Dec., 2003

Fishery and some biological aspects of penaeid shrimps along Saurashtra region

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Abstract

The paper deals with penaeid shrimp fishery off Veraval during 1996-1999. The study coincided with the period of maximum trawl fishing effort and landings of penaeid shrimps. Penaeid shrimp fishery at this centre is constituted by 20 species out of which 10 supported regular fishery. *Parapenaeopsis stylifera* and *Solenocera crassicornis* were the major species contributing to the bulk of the fishery. The relationship between peak penaeid shrimp fishing season and prevailing hydrographic features of the coast during the period of observation is discussed. The size and sex composition, mean size and spawning season of six commercially important varieties are dealt in detail. Though an overall preponderance of female was noticed in all species, the males outnumbered females among smaller groups. For most of the species, the mean sizes of females were higher than that of the estimated size at maturity, indicating that they were getting a chance to breed at least once before their capture. There was no inverse relationship between the quantity caught and the mean size of the shrimps, except for *P. stylifera* and *Metapenaeus monoceros*, indicating that in most of the species, the increase in catch as a result of enhanced fishing pressure was not constituted by the addition of the smaller shrimps or immature ones. All species showed extended spawning season with two peaks.

Introduction

Gujarat, with a coastline of about 1,600 km and a continental shelf area of about 1.65 lakh sq.km is one of the major fish producing maritime states in India. The state has undergone blue revolution in marine fishery sector during past three decades since the mechanization of fishing crafts and improved fishing technology. About 94% of the marine fish production came from mechanised and motorised sectors. The marine fishable stock of the coast is estimated at 7.73-lakh t and the yield has crossed 7-lakh t in 1997. The marine fish landing was 82,000 t in 1971 (7% of the all-India catch) which has increased to 7,00,000 t in 1998 (forming 26 % of all India total). Of the 22,600 fishing boats associated with marine fisheries sector along the coast, 25% of them are trawlers, 14% gill-netters, 20% motorised crafts, 3% other mechanised units and 38% non- mechanised. (Sehara, 1998). Trawlers accounted for more than

60% of the total fish landings. Coastal Gujarat comprises three distinct regions, Saurashtra, Kutch and South Gujarat. Coastal regions of Jamnagar, Rajkot, Porbandar, Junagadh, Bhavnagar and Amreli represent Saurashtra region. Ever since the trawling was introduced along Saurashtra coast in 1967, the fish landings increased rapidly. By 1981, there were 900 trawlers in the Saurashtra region, out of which 666 units were operating from Veraval, (CMFRI, 1978). During 1995, the number of trawlers operated along Saurashtra coast increased to about 3,500 and 70% of them were operating from Veraval, Mangrol and Porbandar. The rapid assessment survey conducted by CMFRI during 1999 indicated that there were 2,290 trawlers operating from Veraval fishing harbour alone.

The author is thankful to Prof. (Dr.) Mohan Joseph Modayil, Director CMFRI, Cochin and Dr. E.V. Radhakrishnan, Head, C F D for their constant encouragement. I would also like to thank Dr. G. Nandakumar and Dr. C. Muthiah, Principal scientists of CMFRI, for critical evaluation of the manuscript and to Shri. B. P. Thumber, Technical assistant for collection of data.

Material and methods

The present study was conducted from September, 1995 to May, 2000 at Veraval. Collections were made twice a week from Bhidia and 'Old light house' landing centres of Veraval. The length data collected on six species of penaeid shrimps for the calendar years 1996 - 1999 were grouped into 5mm-class interval to study of size composition, mean size, maturity and sex ratio. Maturity stages were determined by classifying the females into five categories, viz immature, early maturing, late maturing, mature and spent. Month-wise pooled data was used to determine the fishing and spawning seasons.

Results

Veraval Fishing Harbour

Veraval, in Gujarat, is one of the biggest fishing harbours in India accounting for 34% of the total marine fish landings in the state. It is an important gillnet as well as trawl landing centre. The fishing harbour consists of two distinct portions, viz Bhidia landing centre and Old light house (OLH) landing centre. The trawl catch consisted of sciaenids, ribbonfishes, threadfin breams, whitefish, perches, clupeids, elasmobranchs, eels, flatfishes, catfishes, pomfrets, crustaceans, cephalopods, etc.

Trawl fishery

Wooden boats of 14 m OAL, with engines of 87 to 97 hp. were designed for stern trawling using shrimp trawls with a cod end mesh size of 15 to 20 mm. The boats depart the harbour for fishing in the early morning and returned by evening. The depth of operation was 20 - 60 m and some times extended upto 80 m. (Rao and Kasim, 1985). During 1988-1989, some of the fishermen ventured for multi-day fishing. The experiment was highly successful which changed the trawl fishery scenario of Gujarat. At present, most of the

trawlers go for multi-day fishing. Old boats are either modified or well-equipped new boats constructed to meet the needs of multi-day operations. Duration of fishing operation varied from 4 to 8 days. Most of the trawlers have an OAL of 16 meters and more with tonnage capacity ranging from 10 to12 t and engine power from 87 to 110 hp. Multi-day trawlers generally carry more than one net, which are used according to the species availability. Shrimp trawl generally have a cod end mesh size as small as 8-10 mm and that of fish trawls 15-20 mm. They operate in fishing grounds far away, about 300 km off Veraval, both southward and northward directions i.e., off Satpathi in the south and Jakhau, Okha and Dwaraka in the north. Thus trawl landings at Veraval consist of fishery resources exploited from all along the Saurastra coast and during some periods it covers areas off Kutch and also off south Gujarat (Fig.1). The fishing operations are concentrated in 70 to 110 m depth which is found to be very productive. The major concentration and activities of trawlers are centered around Saurashtra region which comprise nearly 75% of the total units available in Gujarat and contribute more than half of the total

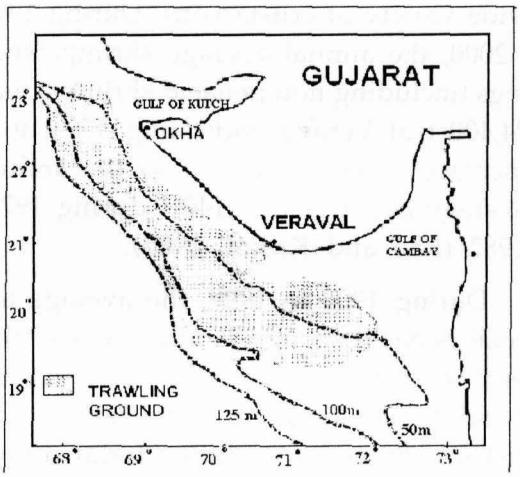


Fig.1. *Area of operation of trawlers from Veraval Fishing Harbour*

fish production of the state. (Sehara, 1998). Trawling season starts from September and extends to May and in some years upto June. Saurashtra fishermen operating mechanised fishing boats observe closed fishing season from June to August.

Shrimp fishery

During late eighties the trawling operation resulted in discovery of rich trawling grounds for crustaceans, especially penaeid shrimps. Along with this discovery, use of reduced cod end mesh size of the gear resulted in heavy landing of a

Table1. *Penaeid shrimp fishery at Veraval Fishing Harbour during 1996-1999.*

Year	Fishing units (nos.)	Fishing hours	Penaeid shrimp catch (t)	Catch per unit (kg)	Catch per hour (kg)
1996	81,068	7,75,588	3,925	42.4	5.0
1997	99,034	10,54,099	5,818	58.7	5.5
1998	70,531	8,51,331	4,805	68.1	5.6
1999	54,208	6,46,005	2,628	48.4	4.0

wide variety of crustaceans. During 1995 - 2000, the annual average shrimp landings (including non penaeid shrimps) was 24,400 t at Veraval indicating a ten fold increase when compared to the annual average landings of 2,140 t during 1979-1982 (Rao and Kasim, 1985).

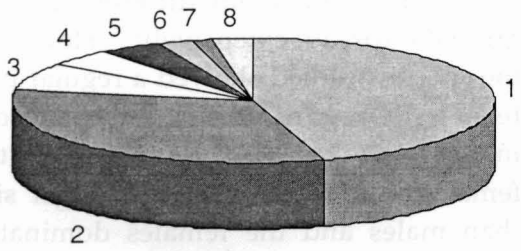
During 1996 to 1999, the average annual penaeid shrimp landing was 4294 t, with maximum observed in 1997 (5,818 t) and the minimum in 1999 (2,628 t). The fishery showed a declining trend during 1998 and 1999. This decrease was mainly due to reduction in the number of trawler units in operation during these two years. Table1 shows that 81,068 trawl units were put into operation during 1996, which resulted in the landing of 3,925 t of penaeid shrimps. In 1997 the number of trawlers increased to about 99,900 and consequently the penaeid landings also showed marked increase with an all time record landing of 5,818 t. But it can be seen that subsequently number of units operated were reduced resulting in lesser production. The reduction in trawler units was mainly due to the following factors, (a) the erratic weather condition prevailed in Gujarat coast during the year and (b) the slide in market demand and price for export oriented commodities like shrimps, lobsters and cephalopods due to the ban imposed by seafood importing countries (c) Increase in fuel price and (d) reduction in shrimp catch per unit.

Species composition

Twenty species represented the penaeid shrimp fishery at Veraval during 1996-1999. Ten species supported regular fishery, five contributed to occasional fishery and another five occurred in stray numbers. Two species of the genus *Parapenaeopsis*, (*P. stylifera* and *P. hardwickii*) three species of genus *Metapenaeus*, (*M. kutchensis*, *M.monoceros* and *M.affinis*) four species of genus *Penaeus*, (*P. semisulcatus*, *P. merguiensis* and *P. penicillatus)* and one species of genus *Solenocera* (*S. crassicornis)* formed regular fishery throughout the fishing season. *Trachypenaeus curvirostris*, *S. choprai*, *Metapenaeopsis stridulans* and *P. sculptilis* formed fishery only during some period of the year. Besides these species *Penaeus latisulcatus*, *P. japonicus*, *P. canaliculatus* and *Metapenaeus brevicornis* were also recorded in the fishery. The total species availability chart during 1996-1999 and break up of the species composition for 1995,1996 ,1997and 1998 are given in the Figures 2 and 3 respectively.

P.stylifera, locally known as *kolmi* was the most common species. Its average annual catch during 1996-99 was 1,940 t forming about 45% of the penaeid shrimp landing. The catch per unit effort (CPUE) was 26 kg. Maximum catch was in 1998, i.e., 2276 t with a CPUE of 32 kg per boat. *P. stylifera* was available throughout the fishing season in appreciable quantity, with a major peak during October-January. A secondary peak of lesser magnitude was observed during April- May.

Coastal mud shrimp, *Solenocera crassicornis*, locally known as *lal kolmi* or *rath kolmi* formed 32% of the penaeid landings during this period. Its annual



1) P.stylifera 45%, 2) S.crassicornis 32%,3) P.hardwickii 7%, 4) M.kutchensis 5%, 5) M.affinis 4.2%, 6) M.monoceros 2.2%, 7) P.semisulcatus 1.4%, 8) others 2.7%

Fig.2. *Species composition of penaeid shrimps (%) landed at Veraval Fisheries harbour during 1996-1999.*

average catch was 1,392 t with a catch of 18 kg per trawler unit. The maximum annual catch of 1,951 t was observed in1997, with a catch rate of 20 kg per boat. This species occurred in the fishery throughout the year. Peak season of the fishery was during March- April with a secondary peak during December -January. A sharp reduction in the landing was observed from1997 onwards. In 1999 the annual landing of this species was only 770 t with a CPUE of 14 kg.

P. hardwickii, locally known as *tiny* formed 7.4% of average penaeid shrimp catch. The maximum annual landing of 770 t was in 1997 and it decreased drastically to a meager 33 t in 1999. The peak landing was observed during February - April.

M. kutchensis (known as *medium jinga)* formed 4.5 % of the penaeid landing during 1996-99. This species is considered as commercially important along the northwest coast of India. The fishery

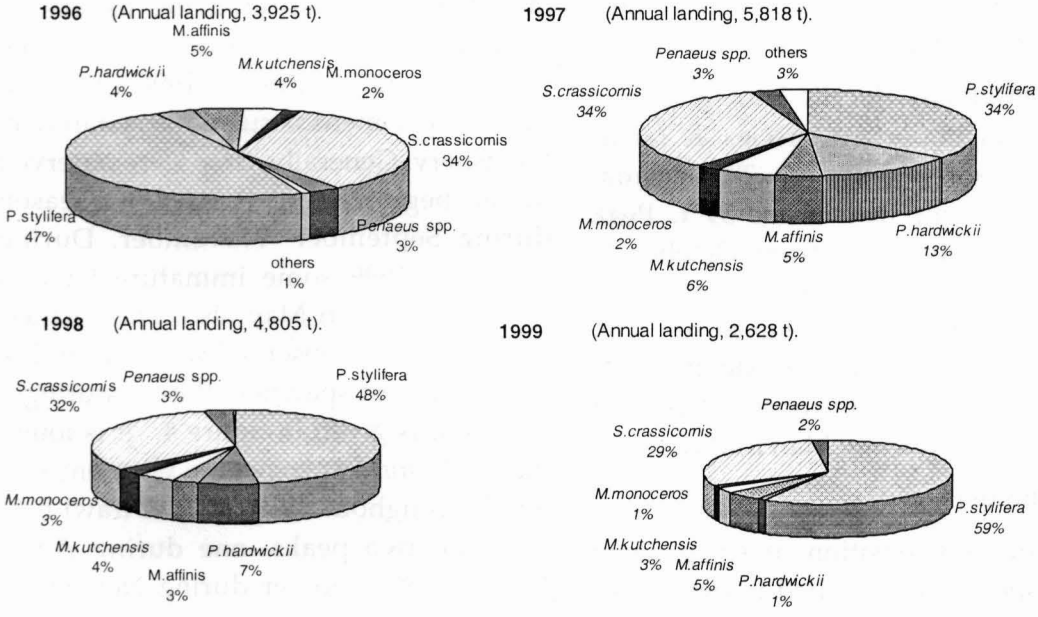


Fig.3. *Annual variation in the species composition of penaeid shrimps at Veraval during 1996-1999*

showed two peaks, a major one during October -December and minor one during February -April. This species also followed a decreasing trend from 1997 onwards. There was a sharp decrease, from 330 t in 1997 to 71 t in 1999, with a decrease in CPUE from 3.3 to 1.3 kg.

M.affinis, (known as *medium jinga*) formed about 4.2% of the penaeid landing during 1996-99. This species also was caught maximum in 1997 (266 t) and declined gradually, but unlike *M. kutchensis,* the landings of this species increased in 1999. The period of abundance was similar to that of *M. kutchensis.*

M. monoceros (known as *kapsi*) is another important shrimp resource found along the Saurashtra coast. Period of abundance of this species also was similar to *M. kutchensis* and *M.monoceros.* The annual average landing of *kapsi* was 95 t. Maximum landing was observed in 1998 (153 t) and minimum in 1999 (38 t).

P. semisulcatus, locally known as *patta jumbo,* is an important species as far as size and export demand. The annual average landing was about 59 t. Peak season of fishery was from October to January. *P. penicillatus* and *P. merguiensis,* locally known as *white jumbo* and *P. monodon* (*Patta Jumbo*) also exhibited two peaks , one during October- December and the other during March-May.

Size composition

The size composition of six penaeid shrimp species was studied in detail during 1996-99. The size range and modal values showed wide variations as fishing was carried out from different fishing grounds spread extensively. However, the species studied showed a regular pattern with regard to sex composition, maturity, etc. In all these species the females were found to attain bigger size than males and the females dominated the fishery. The details of sex wise size range and mean sizes are given in Table 2.

Sex, maturity and spawning

P. stylifera: Females dominated (67%) the fishery during 1996-99 . The sex composition showed marked difference in various size groups. In the size range of 66 - 85 mm, males dominated the fishery and from 86 to 95 mm, the males and females were in almost equal proportion. Above 96 mm the females dominated the fishery and beyond the size of 111 mm, only females constituted the fishery. A total of 2,475 females were used for the maturity studies during 1996-1999. Immature specimens occurred very rarely in the fishery. Generally, they were observed in the beginning of the fishing season during September- November. During 1997 and 1999 some immature females were observed in May also. The smallest matured female observed was 83 mm. The distribution of spawners (late maturing + matured) is given in figure 4. It is found that in *P. stylifera* spawners were encountered throughout the period of trawl fishery with two peaks, one during April-May and the another during November-January.

Table 2. *Size distribution (total length in mm) of commercially important penaeid shrimps landed at Veraval Fisheries Harbour during 1996-1999*

Species/ Year	1996		1997		1998		1999	
	Male	Female	Male	Female	Male	Female	Male	Female
P.stylifera								
Size range	71-110	76-135	56-110	56-135	66-110	71-135	56-105	61-140
Dominant size group	81-85	111-115	85-90	105-110	85-90	115-110	90-95	105-110
Mean size	78.2	109.4	86.0	103.3	87.1	102.4	85.8	103.2
P. hardwickii								
Size range	56-80	66-125	56-80	66-130	51-75	56-135	56-75	66-120
Dominant size group	68-70	96-100	66-70	96-100	66-70	91-95	66-70	96-100
Mean size	70.3	97.6	68.9	97.2	65.5	94.9	64.1	99.0
M. monoceros								
Size range	111-185	111-200	96-185	96-200	101-175	96-220	96-195	106-220
Dominant size group	141-150	161-165	136-140	151-160	140-145	155-160	141-145	155-160
Mean size	141.9	158.1	139.2	158.9	139.6	156.7	140.0	159.6
M. kutchensis								
Size range	86-140	71-150	76-150	76-170	80-150	86-175	81-150	86-165
Dominant size group	115-120	115-120	115-120	121-125	115-120	115-120	115-120	115-120
Mean size	112.3	114.7	114.8	120.4	113.1	121.6	115.1	121.6
P.semisulcatus								
Size range	121-195	126-220	121-190	126-215	116-180	116-230	116-180	136-220
Dominant size group	145-150	165-170	155-160	175-180	155-160	175-180	145-150	155-160
Mean size	149.8	167.2	150.9	171.8	152.6	174.2	147.2	166.3

P. hardwickii: Females formed 86% of the fishery. All shrimps in 51 to 65 mm size were males. The domination of females started from 71 mm size onwards and above 81mm size onwards all shrimps were females. A total of 2223 females were examined for maturity studies. Immature females were found in the fishery almost all the months but, their percentage composition was less than 20 . The smallest mature female recorded was having a length of 80mm. In the case of *P. hardwickii* also the availability of spawners was throughout the year with a distinct peak during February- March and the other starting from May.

M.monoceros: The fishery of this species was dominated by females (63%). Male domination in the fishery was found from a size of 96 mm to 140 mm. Above the size of 141 mm, females dominated the fishery and beyond 196mm, females constituted 100% of the fishery. A total of 1551 females were used for maturity studies. Out of which only 20 specimens were immature. The females above 115 mm were invariably in different stages of maturation. The smallest matured female re-

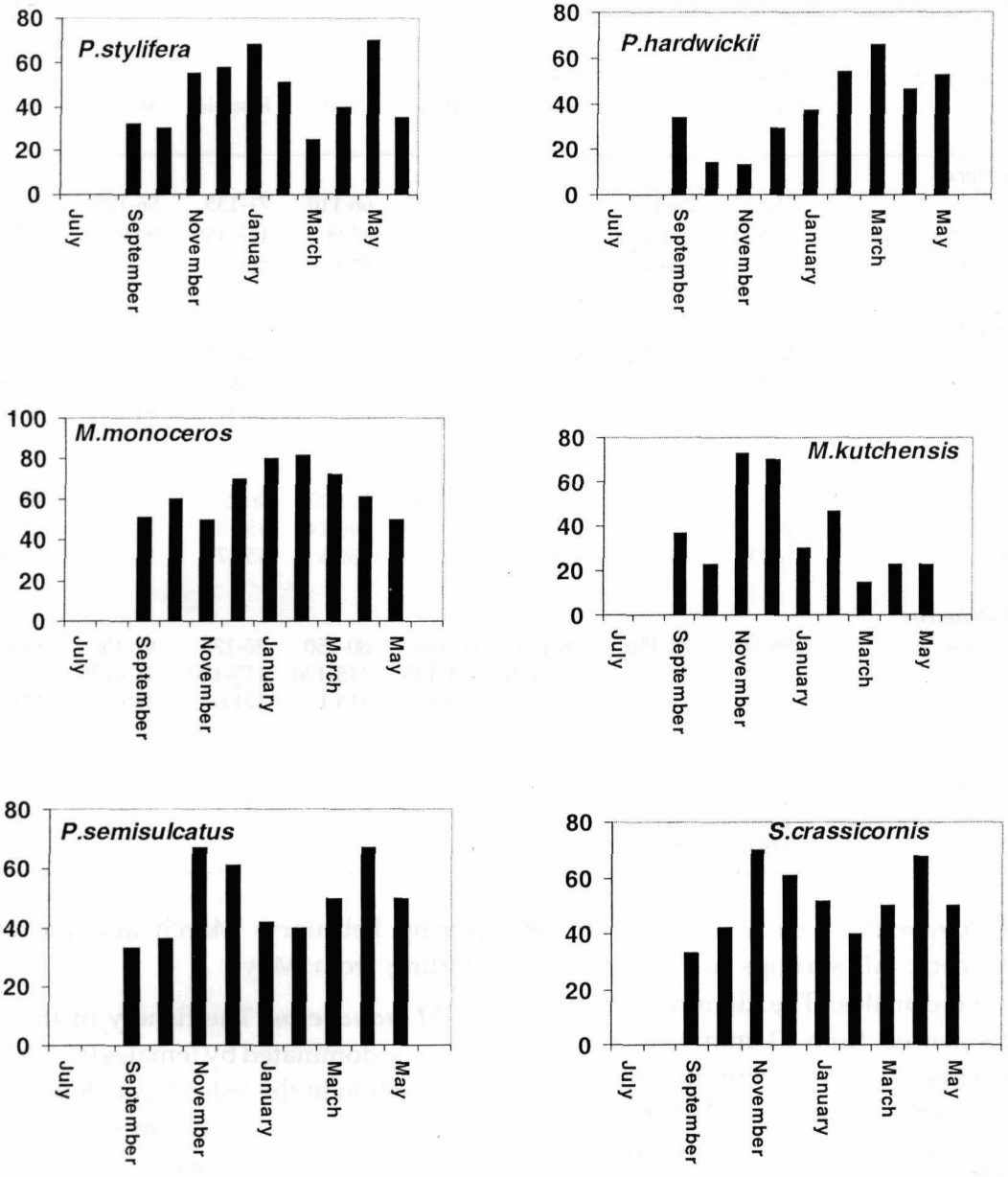


Fig.4. *Month-wise percentage of occurence of spawners (penaeid shrimps) at Veraval during 1996-1999.*

corded was 125 mm. The present studies showed that in *M.monoceros* the spawner percentage was over 50. There were two distinct peaks of spawner availability, a major one during January-March and the minor one during September-October.

M. kutchensis : Females dominated the fishery throughout the season forming 64% of the catch. Males dominated from

Table 3. *Smallest size of the matured females, spawning season and peak fishing season of commercially important penaeid shrimps landed at Veraval Fishing Harbour.*

Species	Peak fishing season	Size range females (mm)	Size of smallest matured female (mm)	Peak spawning season.
P. stylifera	Oct.-Jan.	56- 140	83	Nov.-Jan. & Apr.-May
P. hardwickii	Feb.- Apr.	66-125	80	Feb.-Mar.& May
M.monoceros	Jan.- Mar.	96-220	125	Jan.-Feb. & Sep.- Oct.
M. kutchensis	Oct.-Dec.	71-170	117	Nov.-Dec. & Feb.-Mar.
P. semisulcatus	Oct.- Jan.	116-230	138	Apr.-May. & Nov.-Dec.
S. crassicornis	Mar.- Apr.	41-120	68	Apr.-May & Nov.-Dec.

81mm to 115mm length. Females dominated from 116mm size and beyond 156mm all were females. Here, 1435 females were analyzed. Immature females were present throughout the period of study and their percentage composition was less than 10. The smallest mature female recorded was 117mm. The percentage of spawners was maximum during November-December, and again a minor peak was observed during February- March. Indicating intense spawning activities of the species during these periods.

P. semisulcatus: Females constituted 66% of the *P. semisulcatus* fishery. Upto a size of 145 mm males were found to dominate and from the size of 156 mm, females dominated the fishery and beyond 190 mm, all were females. In *P. semisulcatus*, a total of 1212 females were used for maturity studies, immature specimens were not seen in the fishery except for few numbers observed in 1996. The smallest matured female observed was having a length of 138 mm. Almost 30% of the females were in early maturing stages. The percentage of spawners was maximum during November-December and April-May, clearly indicating the peak spawning activities during these periods.

S. crassicornis : The species of 35 to 60mm length were all males and in the size range of 61 to 75 mm, males dominated the catch. Females started dominating the fishery from the size of 76 mm onwards and above 81mm all were females. In *S. crassicornis* , the smallest matured female measured 68 mm. Maximum number of spawners was observed during April-May and November-December. Detailed studies on the maturity and spawning of these commercially important species are given Figure 4.

Discussion

The period of observation coincided with the period of the maximum number of trawlers in operation along this Saurastra coast in 1997. About 99,000 trawlers were put into operation from Veraval, the highest number ever intro-

duced along Saurashtra coast. During this year total trawl landings and penaeid landings also were the highest. Even though it is too early to spell out the effect of this intense fishing pressure, the catch per unit effort of shrimps decreased considerably during the following years (Table 1).

A comparison of the observation on the species composition, with the results obtained by Rao and Kasim (1985) during 1979-1982, revealed the extent of the changes in the shrimp landings by the trawlers at Veraval over the period of time. According to the earlier study, the annual average shrimp landing at Veraval during 1979-83 period was 2,140 t out of which non-penaeid shrimps contributed 29.3 to 39.9 %. The penaeid shrimp fishery was mainly constituted by *P. stylifera, S crassicornis, M. kutchensis, P. penicillatus* and *P. semisulcatus* forming 20.4 to 30.8%, 4.3 to 10.8%, 4.2 to 10%, 1.7 to 2.2% and 0.6 to 3.4% of the total shrimp landing respectively. *Metapenaeopsis stridulans, Trachypenaeus curvirostris, Parapenaeus longipes and P. monodon* together formed 1.0 to 4.8% (Rao and Kasim, 1985). During 1978-85, Ramamurthy (1994) also reported that all species except *S. crassicornis and P.hardwickii,* were caught abundantly during September -October. Species like *M. monoceros* and *P. semisulcatus* were caught only during September -October in earlier years when the fishery was restricted to a depth of 50m. As a result of the multi-day trawling in deeper waters, these species have become common in the fishery throughout the trawling season. This indicated a seasonal shoreward migration of these species during September-October.

During 1996-99, *P. stylifera* and S. *crassicornis* were the major contributors to the penaeid fishery at Veraval. Both the species dominated the fishery during different period of the year. The maximum landing of *P. stylifera* was during the post monsoon season, from September to December and that of *S. crassicornis* from February to June. Penaeid shrimp fishery of Veraval reached its peak during October - December, mainly coinciding with the good landing of *P. stylifera, Metapenaeus* spp. and *Penaeus* spp. Similar observations were made by Kagwade (1967) and Ramamurty (1967, 1994) in Saurashtra waters, Mohamed (1967) in Bombay waters and Zupanovic and Mohinuddin (1973) in Pakistan waters. The main reason for this good fishery during this period is attributed to the prevailing local upwelling as reported by Jayaraman and Gogate (1957). According to them upwelling occurs along northwest coast of India during September-October and is caused by north-east monsoon. Zupanovic and Mohinudin (1973) while studying the depth wise distribution of shrimps have reported that in the north Arabian Sea, the shrimps migrate towards the shore coinciding with the upwelling from September onwards and they migrate back to the deeper waters from January. Recent remote sensing studies on the hydrographic characters and fisheries of Gujarat conducted by Solanki *et al,* (1998) revealed that persistent upwelling occurs along the

northwest region especially along Saurashtra coast during September. During the initial phase of upwelling, the oxygen deficient but nutrient rich bottom water moves towards the surface close to the shore. Fishes try to move away from this area during this stage. After stabilization, due to nutrient enrichment, primary production increases and this nourishes entire food chain of the area. They attributed these factors as the major reason for the good landing of shrimps during October-November.

It is seen that even though the landings of penaeid shrimps increased, there was no reduction in the mean size of the penaeid shrimps during 1997. In the subsequent years also except in the case of *P. semisulcatus*, no other shrimp species showed any notable reduction in their mean size. The mean size of females of all penaeids except *M.kutchensis* and *P.semisulcatus* caught during the period also was higher than the size at maturity, which showed that they were getting an opportunity to spawn at least once before they were caught. Another important aspect of the shrimp fishery at Veraval is that the minimum percentage of the juvenile and immature shrimps encountered in the fishery shows that the habitats occupied by the immature shrimps are still protected. In all the species studied the males were absent beyond a particular size. All the species indicated an extended spawning period through out the year and all of them showed two peaks in the fishery, one coincided with the pre monsoon and the other with the post monsoon period. Many workers have studied the growth rates, of *P. stylifera*, *P.hardwickii*, *M. kutchensis* and *S. crassicorn*is (Mohamed, 1967; Sukumaran and Rajan, 1981; Deshmukh, 1975; and Deshmukh, 1975 respectively) along the northwest coast of India. It is the 0- year and one-year class that mainly constituted the fishery of these species along Saurashtra coast during 1996-99.

One of the striking features of shrimp fishery at Veraval is that the comparatively bigger size of the shrimps contributing the fishery than the size reported from the other parts of the country. In *P. stylifera* , a size beyond 130 mm is a rare occurrence in the southern parts of the country but a size beyond this supports a regular fishery along Saurashtra coast. The stock of this bigger sized population needs to be studied for understanding their biochemical and genetic variations.

In all species studied, preponderance of female was observed in larger size groups. The preponderance of males in smaller size groups and females in larger size groups were reported by Zupanovic and Mohinudin (1973), Thomas (1974), Kurup and Rao (1974) and Ramamurthy (1994) in their studies on the reproductive biology of various shrimps species along west coast of India.

During the present study it was observed that *P. stylifera* have a continuous breeding season with two peak spawning seasons, one during November-January and the other during the onset of monsoon. Ramamurthy (1994) reported that

along north west coast of India, *P. stylifera* breeds throughout the year with the peak during August and November. And a secondary peak is also found during February -April. During the present study along Saurashtra coast, it was found that the periodicity of spawning in both peaks was delayed by few weeks to one month. Zupanovic and Mohinuddin (1973) observed similar findings in Pakistan waters. In the present observations the smallest ripe female seen was having a length of 83 mm. From Bombay waters Ramamurthy (1994) recorded the smallest ripe female of 83 mm and Kagwade (1980) estimated the length at maturity as 105.5 mm.

In *P.hardwickii*, the smallest mature female observed during the present study was 80mm and the maximum number of spawners was observed during January and May. In Bombay waters, Kunju (1967) and Sukumaran and Rajan (1981) observed matured females as small as 70 mm and 63 -68 mm respectively. In *M.monoceros*, Ramamurthy (1994) recorded smallest ripe females of length of 118 mm from Bombay waters compared to 125 mm observed in the present study. The peak spawning season was found to be during March-April and September. Zupanovic and Mohinuddin (1973) reported that in Pakistan waters *M.monoceros* spawns during February-May. In *S. crassicornis* smallest mature female measured 68 mm and the peak spawning seasons were during May and December. Kunju (1967), Mohamed (1967) and Sukumaran (1979) reported that *S.crassicornis* spawns during December and May in Bombay waters and the size at maturity was estimated between 63 and 83mm.

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